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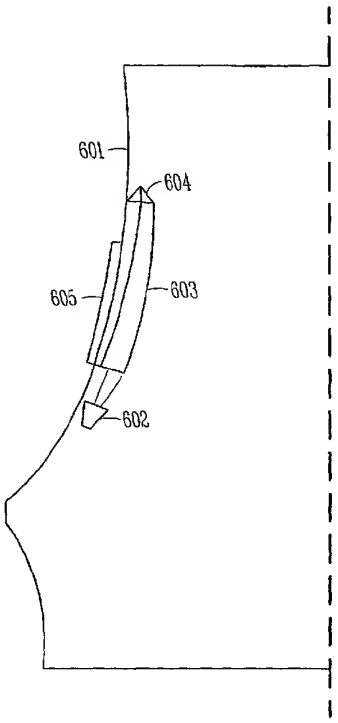
(54) Title: WAGERING GAME SYSTEM WITH WAVEGUIDE PROJECTION DISPLAY



(57) Abstract: A computerized wagering game system includes a gaming module comprising gaming code which is operable when executed on to conduct a wagering game on which monetary value can be wagered, and a wedge waveguide display assembly. In one embodiment, the wedge waveguide display assembly comprises a projector operable to project an image and a wedge waveguide assembly operable to reflect the projected image at least twice before the projected image becomes visible on an image screen region of the wedge waveguide display assembly.

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WAGERING GAME SYSTEM WITH WAVEGUIDE PROJECTION DISPLAY

Related Applications

This application claims the priority benefit of U.S. Provisional Application Serial No. 60/715,521, filed September 9, 2005, the contents of which are incorporated herein by reference.

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Field of the Invention

The invention relates generally to computerized wagering game machines, and more specifically to computerized wagering game machines employing waveguide projection displays.

Background

Computerized wagering games have largely replaced traditional mechanical wagering game machines such as slot machines, and are rapidly being adopted to implement computerized versions of games that are traditionally played live such as poker and blackjack. These computerized games provide many benefits to the game owner and to the gambler, including greater reliability than can be achieved with a mechanical game or human dealer, more variety, sound, and animation in presentation of a game, and a lower overall cost of production and management.

The elements of computerized wagering game systems are in many ways

the same as the elements in the mechanical and table game counterparts in that they must be fair, they must provide sufficient feedback to the game player to make the game fun to play, and they must meet a variety of gaming regulations to ensure that both the machine owner and gamer are honest and fairly treated in implementing the game. Further, they must provide a gaming experience that is at least as attractive as the older mechanical gaming machine experience to the gamer, to ensure success in a competitive gaming market.

Computerized wagering games do not rely on the dealer or other game players to facilitate game play and to provide an entertaining game playing environment, but rely upon the presentation of the game and environment generated by the wagering game machine itself. Incorporation of audio and video features into wagering games to present the wagering game, to provide help, and to enhance the environment presented are therefore important elements in the attractiveness and commercial success of a computerized wagering game system. It is not uncommon for audio voices to provide instruction and help, and to provide commentary on the wagering game being played. Music and environmental effects are also played through speakers in some wagering game systems to enhance or complement a theme of the wagering game. These sounds typically accompany video presentation of the wagering game on a screen, which itself often includes animation, video, and three-dimensional graphics as part of presentation of the wagering game.

The displays were traditionally cathode ray tubes, or CRTs much like those used in standard televisions. But recently, CRT displays have given way to liquid crystal displays as the most common type of display used in new wagering game machines. While CRTs provided very good brightness and color fidelity, they were relatively large, heavy, fragile, and consumed a relatively large amount of power. LCD displays have limited brightness and contrast capabilities, and backlighting a large LCD display evenly and achieving accurate color fidelity are difficult. Other options include plasma displays, which have the color fidelity of CRTs and a small size similar to LCDs, but the contrast ratio, power consumed, and production cost are all inferior to other display technologies. These traditional display technologies are also not easily integrated with mechanical elements such as reels on a mechanical reel slot machine, limiting practical application to traditional rectangular opaque displays.

Further, the complicated processes used to produce these displays results displays that become very expensive as size increases from several inches to several feet diagonal.

It is therefore desired to incorporate display technology into a wagering game system addressing the shortcomings of existing displays.

Summary

One example embodiment of the invention comprises a computerized wagering game system including a gaming module comprising gaming code which is operable when executed on to present a wagering game on which monetary value can be wagered, and a wedge waveguide display assembly. In one embodiment, the wedge waveguide display assembly comprises a projector operable to project an image and a wedge waveguide assembly operable to reflect the projected image at least twice before the projected image becomes visible on an image screen region of the wedge waveguide display assembly.

Brief Description of the Figures

Figure 1 shows a computerized wagering game machine, as may be used to practice some example embodiments of the invention.

Figure 2 shows projected light rays in a waveguide, consistent with some example embodiments of the invention.

Figure 3 shows a projector and a wedge waveguide, consistent with some example embodiments of the invention.

Figure 4 shows a wedge waveguide assembly having a collimating lens, consistent with some example embodiments of the invention.

Figure 5 shows a folded wedge waveguide assembly using a curved waveguide, consistent with some example embodiments of the invention.

Figure 6 shows a folded wedge waveguide assembly using prisms mounted in a wagering game cabinet, consistent with some example embodiments of the invention.

Detailed Description

In the following detailed description of example embodiments of the invention, reference is made to specific examples by way of drawings and

illustrations. These examples are described in sufficient detail to enable those skilled in the art to practice the invention, and serve to illustrate how the invention may be applied to various purposes or embodiments. Other embodiments of the invention exist and are within the scope of the invention, and logical, mechanical, electrical, and other changes may be made without departing from the subject or scope of the present invention.

Features or limitations of various embodiments of the invention described herein, however essential to the example embodiments in which they are incorporated, do not limit the invention as a whole, and any reference to the invention, its elements, operation, and application do not limit the invention as a whole but serve only to define these example embodiments. The following detailed description does not, therefore, limit the scope of the invention, which is defined only by the appended claims.

The invention in one example embodiment comprises a computerized wagering game system including a gaming module comprising gaming code which is operable when executed on to present a wagering game on which monetary value can be wagered, and a wedge waveguide display assembly. In one embodiment, the display comprises a projector operable to project an image and a wedge waveguide operable to reflect the projected image at least twice before the projected image becomes visible on an image screen region of the wedge waveguide display assembly.

Figure 1 illustrates a computerized wagering game machine system, as may be used to practice various embodiments of the present invention. The computerized gaming system shown generally at 100 is a video wagering game system, which displays information for at least one wagering game upon which monetary value can be wagered on video display 101. Video display 101 is in various embodiments a CRT display, a plasma display, an LCD display, a field emission display, or any other type of display suitable for displaying electronically provided display information. Further embodiments include alternate or additional displays, such as a second display located above the primary display, or other displays coupled to the wagering game system. Alternate embodiments of the invention will have other game indicators, such as mechanical reels instead of the video graphics reels shown at 102 that comprise a part of a video slot machine wagering game.

A wagering game is implemented using software within the system, such as through instructions stored on a machine-readable medium such as a hard disk drive or nonvolatile memory. In some further example embodiments, some or all of the software stored in the wagering game machine is encrypted or is verified using a hash algorithm or encryption algorithm to ensure its authenticity and to verify that it has not been altered. The game of chance implemented via the loaded software takes various forms in different wagering game machines, including such well-known wagering games as reel slots, video poker, blackjack, craps, roulette, or hold 'em games. The wagering game is played and controlled with inputs such as various buttons 103 or via a touchscreen overlay to video screen 101. In some alternate examples, other devices such as pull arm 104 used to initiate reel spin in this reel slot machine example are employed to provide other input interfaces to the game player.

Monetary value is typically wagered on the outcome of the games, such as with tokens, coins, bills, or cards that hold monetary value. The wagered value is conveyed to the machine through a changer 105 or a secure user identification module interface 106, and winnings are returned via the returned value card or through the coin tray 107. Sound is also provided through speakers 108, typically including audio indicators of game play, such as reel spins, credit bang-ups, and environmental or other sound effects or music to provide entertainment consistent with a theme of the computerized wagering game. In some further embodiments, the wagering game machine is coupled to a network, and is operable to use its network connection to receive wagering game data, track players and monetary value associated with a player, and to perform other such functions. In some such embodiments, the wagering game machine serves to present a wagering game implemented or conducted on another computer, such as where the wagering game system is a handheld terminal or is a device such as a PDA or cell phone provided by the game player. In other examples. the wagering game system is operable to download wagering games from the wagering game system, or the wagering game system is operable to coordinate community gaming among multiple wagering game machines.

The display 101 is in one embodiment a wedge waveguide projection display, utilizing an image projector and a wedge waveguide utilizing internal reflection to reflect the image onto an image portion of the wedge waveguide

element. The wedge waveguide in some embodiments comprises mirrors or other reflective material, but in alternate embodiments uses a waveguide material having an index of refraction greater than that of air, and the principle of internal reflection for light hitting a surface of such a material at an angle greater than a critical angle combined with a wedge-shaped waveguide contour to reflect a projected image until the critical angle is passed and the image projects from an image screen portion of the waveguide.

This principle of internal reflection is illustrated more fully in Figure 2, which shows an optical waveguide medium 201 in air, where the optical waveguide has an index of refraction greater than the index of refraction of air. The index of refraction is the amount by which light is slowed relative to the speed of light in a vacuum, although the speed if light in air is nearly as fast, yielding an index of refraction of 1.0003. Common transparent materials have higher indices of refraction, such as glass, which typically has an index of refraction of 1.5-1.9, meaning light travels through glass at a speed 1.5-1.9 times slower than through a vacuum.

When light travels from a material having a higher index of refraction to a material having a lower index of refraction, the light changes direction such that the angle between the light's direction and a line perpendicular to the interface between the two materials is increased. This is shown by the light ray 202, which shows both how a light ray leaving the high index of refraction material 201 into a medium with a lower index of refraction such as air changes direction such that it is at a greater angle to a line perpendicular to the interface between material 201 and the air, and how a light ray traveling the opposite direction from the air into the high index of refraction material 201 changes direction such that the light is refracted to a path having a smaller angle with a line perpendicular to the interface between materials.

The angle at which the light is refracted can be calculated using Snell's law, which simply states that for two materials 1 and 2 having indexes of refraction n1 and n2, the angle of refraction of light traveling through the interface can be calculated by the formula:

$n1*\sin(a1)=n2*\sin(a2)$

where the angles a1 and a2 are the angles of the light's path in the respective mediums 1 and 2 relative to the line perpendicular to the interface

between the two materials. If one angle is known and the indices of refraction of the two materials are known, the angle of the light's travel in the other medium can be calculated using the Snell's Law formula.

When the angle of the light beam 202 traveling through the high index of refraction material 201 hits the interface with a material having a lower index of refraction, the light ray doesn't leave the high index material 201 but is completely internally reflected as shown at 203 when the light strikes the interface at the critical angle ac shown at 204 or at an angle greater than the critical angle. The critical angle is based on the index of refraction of the two materials, and can be calculated using the formula:

$$\sin(ac)=n2/n1$$

where n1 is the index of refraction of the material 201 and n2 is the index of refraction of the lower index material such as air. The light is reflected off the interface between materials at the same angle at which it strikes the interface, which enables technologies such as fiber optic cables to internally reflect light repeatedly over very long distances in materials having good optical transparency.

This principle is also used in some embodiments of the wedge waveguide to repeatedly internally reflect a projected image, until the wedge shape of the waveguide causes the image to eventually strike an image portion of the wedge waveguide at an angle smaller than the critical angle and leave the wedge waveguide. This is illustrated in Figure 3, which shows a simple version of a wedge waveguide display as can be used in some example wagering game system embodiments.

A projector 301 projects an image such as the details of a wagering game being presented in a wagering game device containing a wedge waveguide projection display. The image is projected into the wider end of the wedge-shaped waveguide 302, such that the image reflects between the wedge waveguide's edge as shown at 303 at an angle from perpendicular that is greater than the critical angle, resulting in complete internal reflection of the projected image. But, because the waveguide is wedge-shaped, the angle of incidence with the waveguide edges does not remain constant from reflection to reflection, but becomes progressively smaller as is shown by the image ray shown at 303.

As the angle of the reflected image becomes smaller relative to the lines perpendicular to the sides of the wedge-shaped waveguide, the reflected image eventually hits a waveguide edge at an anger lower than the critical angle, and is projected from the waveguide. In the wedge waveguide projection display shown in Figure 3, this occurs in the screen or image portion of the waveguide 304, which results in the projected image becoming visible through that portion of the wedge waveguide.

In a further embodiment, a projection screen as shown at 304 is attached to the waveguide at the image screen portion of the waveguide. The projection screen is in some such embodiments configured to receive the light ray 303 projected from the wedge waveguide at the angle shown in Figure 3, and to disperse or re-focus the light so that it is visible over a broader range of angles or at an angle different than that shown by the image light ray 303 exiting the wedge waveguide. Examples of such projection screens include diffraction gratings, Fresnel lenses, and frosted or rough-surfaced screens such as are commonly used for rear projection.

In a further embodiment, the wedge waveguide is interrupted by one or more lenses, as is shown in Figure 3. The projector 401 projects an image through the first waveguide portion 402 and into image screen portion 403, but the waveguide portions 402 and 403 are separated by a collimating lens 404. The projected image spreads wider as it projects farther from the projector, as shown at 405. To prevent the image from continuing to spread wider across the face of the image screen portion 403 of the wedge waveguide display assembly, a collimating lens 404 is used once the image has spread to the appropriate width for the image screen portion 403 to collimate the image, or to refocus the projected image so that it doesn't continue to spread wider as it progresses further away from the projector.

This lens is in some embodiments therefore designed in conjunction with the specific lens characteristics of the projector 401, so that the rate of image spreading from the projector can be properly compensated in the collimating lens 404 to ensure that the image projected from the collimating lens doesn't converge or diverge. The collimating lens is in various embodiments located between parts of the wedge waveguide or incorporated into the wedge waveguide. The collimating lens is in some embodiments incorporated into the

wedge display assembly with no air gap between the first waveguide portion 402 and the image screen portion 403, such as by using a collimating lens having a significantly higher index of refraction than the wedge waveguide material.

The various elements shown, including the wedge waveguide, the image screen, the collimating lens, the projector, and other such elements can be configured in a variety of combinations and physical configurations in various embodiments. For example, Figure 5 shows a curved wedge waveguide projection display assembly, illustrating one example of a change in physical configuration of the components in a wedge waveguide projection display. The projector 501 projects an image into the wide end of the folded wedge waveguide 502, which receives the image and reflects it internally much like the flat wedge waveguide 302 of Figure 3, except that the waveguide is curved and the reflected image's path curves along with the wedge waveguide before becoming a visible image projected from image screen area 503 of the folded wedge waveguide.

Another embodiment uses folded prisms having mirrored external surfaces to replace the fold portion of the folded wedge waveguide 502 of Figure 5, resulting in an even flatter "folded" wedge waveguide configuration. Such a wedge waveguide is shown in Figure 6, which also shows how such a display can be incorporated into a wagering game cabinet such as that of Figure 1. The wagering game cabinet 601 contains a projector 602 and a folded wedge waveguide 603. The waveguide 604 is folded, and uses prisms 604 to reflect the image around the corner and toward the image screen portion 605 of the waveguide.

The folded wedge waveguide is in some embodiments fixed in place using mechanical means, such as brackets, adhesive, bolts or other fasteners, or other such means. The image screen portion 605 is configured to be visible from the exterior of the wagering game cabinet 601, in a position designed for the wagering game player to easily view the presented images. Other embodiments include use of a folded wedge display in other positions within the wagering game cabinet, such as in a secondary display configuration, in a side display or other display configuration, or in a separate enclosure such as a top-box coupled to the wagering game cabinet.

The examples presented here show how a waveguide having at least a portion shaped as a wedge can be used in wagering game systems to display information such as to present a wagering game, to present video or multimedia, or to produce other visible images from a projector. The projector need not be located a great distance from the image screen or configured to project an image directly perpendicular to an image screen, as is the case with traditional image projection technology.

Although specific embodiments of such wagering game systems and methods of use have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement or method which is calculated to achieve the same purpose may be substituted for the specific embodiments described. This application is intended to cover any adaptations or variations of the example embodiments of the invention described herein, and it is intended that this invention be limited only by the claims and the full scope of equivalents thereof.

Claims

1. A computerized wagering game system, comprising:

a gaming module comprising gaming code which is operable when executed to present a wagering game on which monetary value can be wagered; and

a wedge waveguide display assembly, comprising a projector operable to project an image and a wedge waveguide operable to reflect the projected image at least twice before the projected image becomes visible on a image screen region of the wedge waveguide display assembly.

2. The computerized wagering game system of claim 1, wherein the projector comprises at least one of a liquid crystal display projector, a digital micromirror device projector, a laser projector, or a liquid crystal on silicon projector.

3. The computerized wagering game system of claim 1, wherein the wedge waveguide comprises two mirrors.

4. The computerized wagering game system of claim 1, wherein the wedge waveguide comprises a wedge-shaped element made of optically transparent material.

5. The computerized wagering game system of claim 4, wherein the optically transparent material has an index of refraction greater than the index of refraction of air.

6. The computerized wagering game system of claim 5, wherein wedge waveguide is operable to project an image onto the image screen region of the folded projection display assembly by internally reflecting the projected image such that the projected image strikes the image screen portion of the wedge waveguide at an angle greater than the critical angle of the wedge waveguide.

7. The computerized wagering game system of claim 1, wherein the image screen region is a curved section configured to simulate a mechanical reel.

8. The computerized wagering game system of claim 1, wherein the wedge waveguide display comprises at least one of a main display, a top box display, and a supplemental media display.

9. A method of operating a computerized wagering game system, comprising:

presenting a wagering game upon which monetary value can be wagered; and

projecting an image via a projector through a wedge waveguide display assembly operable to reflect the projected image at least twice in a wedge waveguide element before the image becomes visible on a image screen region of the wedge waveguide display assembly.

10. The method of operating a computerized wagering game system of claim 1, wherein the projector comprises at least one of a liquid crystal display projector, a digital micromirror device projector, a laser projector, or a liquid crystal on silicon projector.

11. The method of operating a computerized wagering game system of claim 1, wherein the wedge waveguide comprises two mirrors.

12. The method of operating a computerized wagering game system of claim 1, wherein the wedge waveguide comprises a wedge-shaped element made of optically transparent material.

13. The method of operating a computerized wagering game system of claim 12, wherein the optically transparent material has an index of refraction greater than the index of refraction of air.

14. The method of operating a computerized wagering game system of claim 13, wherein wedge waveguide is operable to project an image onto the image screen region of the folded projection display assembly by internally reflecting the projected image such that the projected image strikes the image screen portion of the wedge waveguide at an angle greater than the critical angle of the wedge waveguide.

15. The method of operating a computerized wagering game system of claim 1, wherein the image screen region is a curved section configured to simulate a mechanical reel.

16. The method of operating a computerized wagering game system of claim 1, wherein the wedge waveguide display comprises at least one of a main display, a top box display, and a supplemental media display.

17. A computerized wagering game machine, comprising:

a wedge waveguide projector display assembly configured to present a wagering game upon which monetary value can be wagered by internally reflecting a projected image in a wedge waveguide element having an index of refraction greater than the index of refraction of air, such that the projected image strikes an image screen portion of the wedge waveguide at an angle greater than the critical angle of the wedge waveguide and becomes visible to a wagering game player.

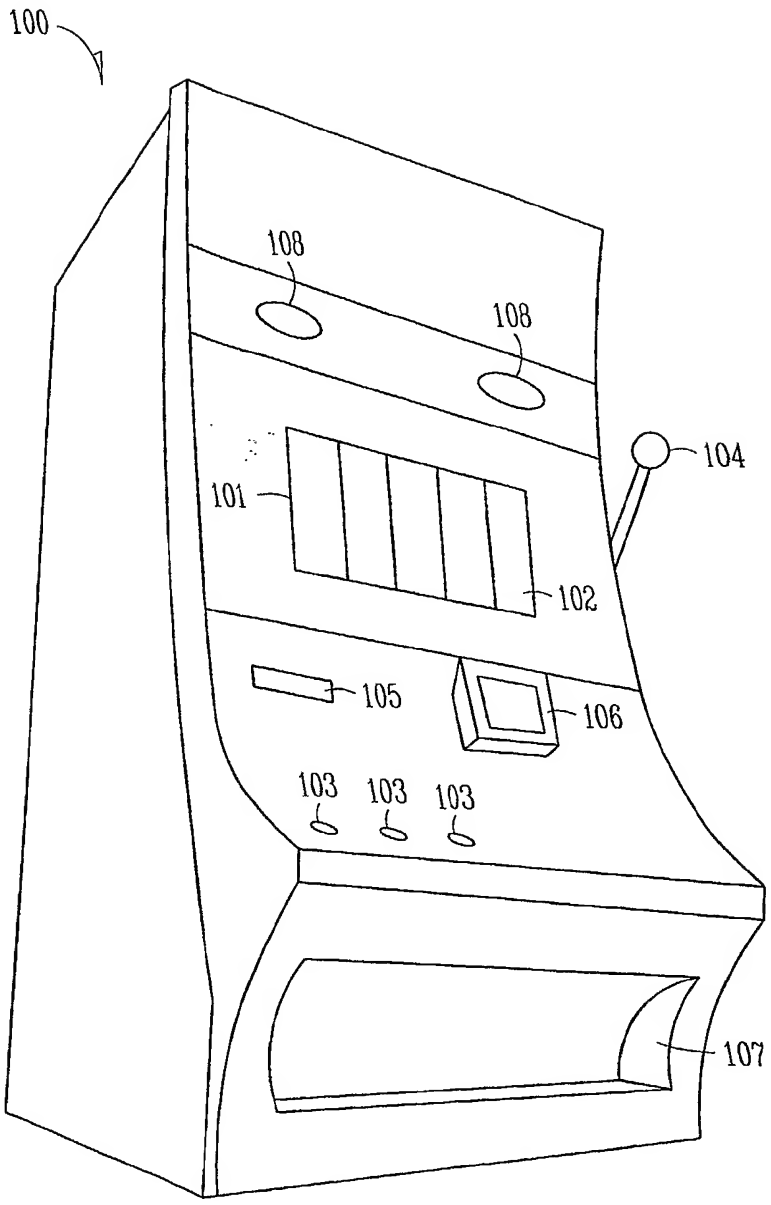

FIG. 1

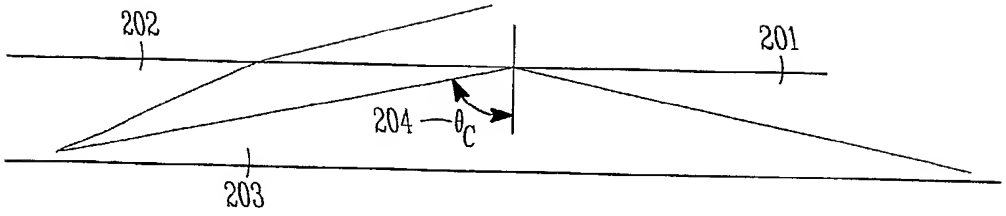

FIG. 2

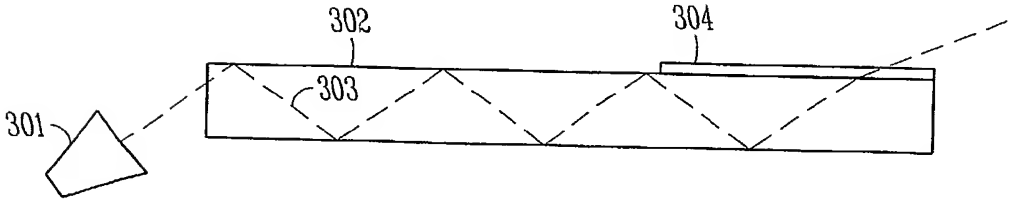

FIG. 3

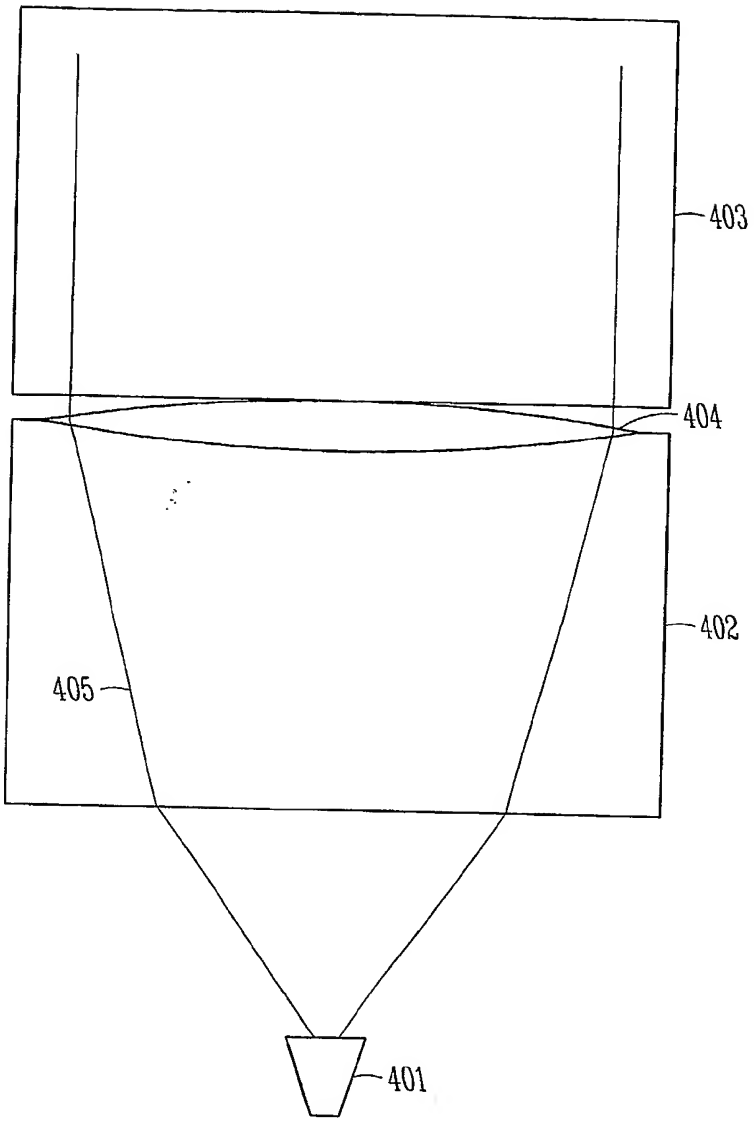

FIG. 4

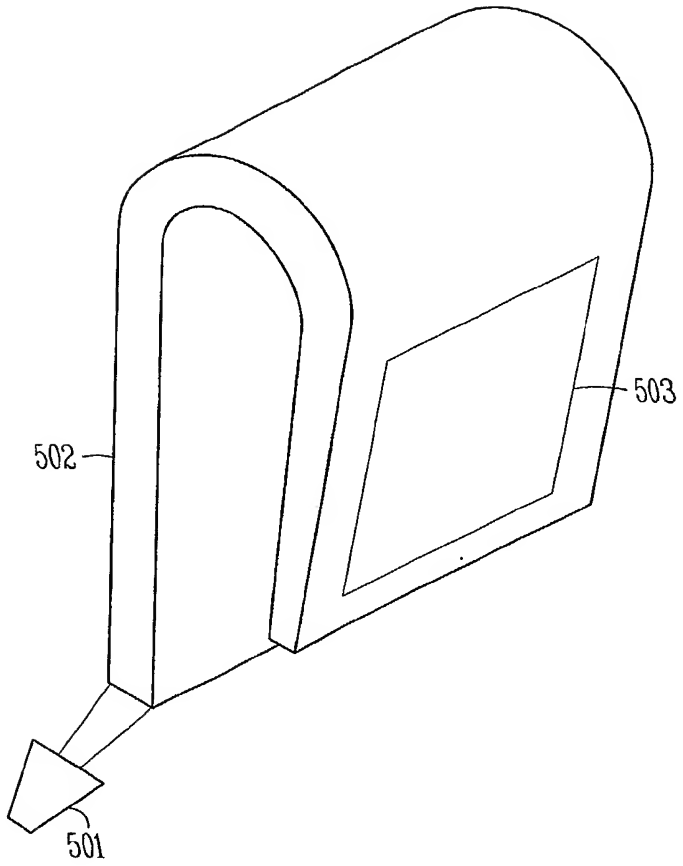

FIG. 5

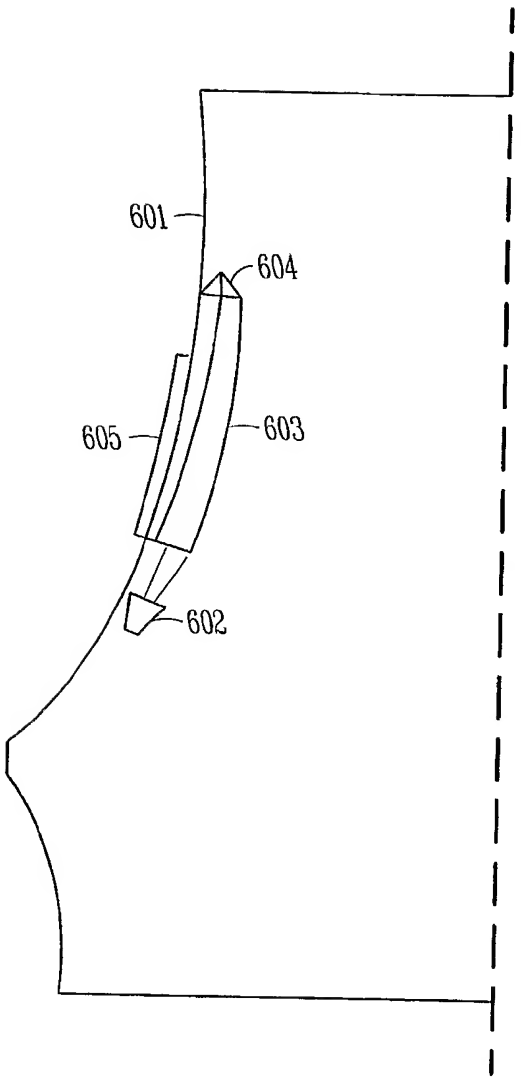

FIG. 6